FEDERAL AID IN FISH RESTORATION
STUDY G-I

INVENTORY AND CATALOGING

By: F.D. Van Hulle, J.B. Murray, S.L. Hammarstrom, D.A. Watsjold, L.A. Gwartney, F.T. Williams, S.W. Kubik and J.C. Riis

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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

INVENTORY AND CATALOGING

by

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RESEARCH PROJECT SEGMENT

State: ALASKA

Name: Sport Fish Investigations of Alaska.

Project No.: F-9-8

Study No.: G-I

Study Title: INVENTORY AND CATALOGING

Job No.: G-I-D

Job Title: Inventory, Cataloging and Population Sampling of the Sport Fish and Sport Fish Waters in Upper Cook Inlet.

Period Covered: July 1, 1975 to June 30, 1976.

ABSTRACT

Morphometric data are presented for 31 Matanuska-Susitna valley lakes. The lakes range in surface area from 5-362 acres and from 17-177 feet in depth.

A summary of chemical characteristics of 41 Matanuska-Susitna valley lakes is presented. All but five lakes were characterized by a predominance of Ca^{++} among the cations and HCO_3^- among the anions.

Seasonal thermal and dissolved oxygen patterns in Matanuska-Susitna valley lakes of varying productivity are discussed.

The value of the morphoedaphic index (MEI) as an indicator of productivity is discussed. Correlations between the MEI and plankton indices, dissolved oxygen reduction, water chemistry, and fish growth are determined in a number of lakes with varying levels of productivity.

Growth and survival, as defined by gill net sampling, were determined for stocked game fish in 20 lakes. Mean lengths for Ennis, Montana rainbow trout, *Salmo gairdneri* (Richardson) after 4.5 months of lake residency, ranged from 162-201 mm. Average lengths of Winthrop, Washington rainbow trout ranged from 209-356 mm after 17 months. Gill net data are also

presented for Arctic grayling, *Thymallus arcticus* (Pallas), and coho salmon, *Oncorhynchus kisutch* (Walbaum). Growth curves are presented which reflect the expected growth of rainbow trout and coho salmon during their first two growing seasons.

Chinook salmon, *O. tshawytscha* (Walbaum) escapement surveys were conducted on 13 streams from July 28-August 5, 1975. The 1975 escapement estimate of 1,500 chinook was considerably lower than the 1973 and 1974 estimates of 8,900 and 4,100, respectively.

Foot surveys were conducted on seven streams to enumerate coho salmon. The 1975 escapements on several streams were higher than for previous years' averages.

Recommendations for 13 public easements were submitted to the Habitat Section along with documentation of past, present, and future "use" of each easement requested.

BACKGROUND

The Matanuska-Susitna valleys have a great abundance of lakes that contain, or have the potential of producing game fish. Collectively, the lakes support a substantial recreational fishery, yet prior to 1973 very little was known about these environments or their levels of fertility. In consideration of the need for this information, in 1973 a limnological inventory of stocked lakes was initiated by Engel (1974), with an objective of establishing indices of productivity for lakes in the Matanuska-Susitna valleys.

The goal of the inventory was to compare the area's stocked lakes by as many criteria as practical to determine causes for differences in game fish production and, if feasible, to determine whether any individual factors consistently control this production.

Watsjold (1975) expanded this inventory to include not only stocked lakes but lakes appearing to have management potential. The broad scope of the inventory allows it to complement the more specific limnological game fish studies of Kalb (1974-1975).

During this job segment data collected during the past three years were combined to determine which physical, chemical, and biological factors may be useful as indicators of lake fertility.

RECOMMENDATIONS

Emphasis should be directed toward the following activities:

1. Catalog chemical and physical parameters of lakes in the area and determine which parameters may be useful indicators of productivity.

2. Determine relative growth and survival of salmonids in stocked lakes and relate this data to the productivity of the various managed lakes.

3. Continue evaluation of various sampling techniques that are presently employed in the area.

4. Determine chinook and coho salmon escapements in selected streams of the area.

OBJECTIVES

1. To determine and record the environmental characteristics of certain potential fishery waters of the job area and to develop and evaluate plans for the enhancement of resident fish stocks.

2. To assist as required in the investigation of public access status to the area's fishing waters and to make specific recommendations for selection of sites for segregation.

3. To make recommendations for the proper management of various sport fish waters in the area and to direct future studies.

TECHNIQUES USED

Detailed volumetric surveys were conducted using a recording fathometer and aerial photo techniques. A polar planimeter was used to compute the acre feet in each lake. A map measurer was used to determine shoreline lengths.

Samples and/or measurements from lakes were taken from permanent sampling stations near the area of maximum depth. Water temperatures were measured with a Yellowsprings Model 43 Thermistemp Tele-Thermometer graduated in degrees Fahrenheit. Specific conductance was measured with a Hach Model 2510 conductance meter.

Dissolved oxygen was determined by titration with phenylarsene oxide (PAO) and powder pillows developed by Hach Chemical Company. Vertical dissolved oxygen series were collected on a monthly basis to determine the amount of winter O_2 reduction in 11 lakes. Samples were collected at 3 m intervals to the maximum depth at the sampling station. In each lake the average of the O_2 series was calculated once in November and again in April, and the percent of O_2 reduction during this time period was computed.

Monofilament gill nets (125x6') with five mesh sizes ranging from 0.5-2 inch bar measure, were used to collect fish specimens. Nets were normally set for 24 hours in each lake.

The age of planted salmonids was determined, when necessary, by examination of scales pressed between glass slides.

Fork lengths were recorded to the nearest millimeter and weight to the nearest 0.01 pound.

Chinook spawning populations were enumerated by aerial, boat, and streambank surveys while coho spawning populations were enumerated by foot surveys within established index areas.

A temporary weir was located on Fish Creek immediately downstream from the Goose Bay-Wasilla Highway culvert. The weir was operated from July 3-September 11 to enumerate all salmon species entering the Fish Creek system. The weir, constructed by the Commercial Fish Division, was described by Watsjold (1974).

FINDINGS

Results

Limnological Studies:

Factors affecting growth and survival of fish in waters of varying productivity in the Matanuska-Susitna valleys are not fully understood. It does not appear that any individual factor, whether it be physical, chemical, or biological, consistently controls production. Ryder (1965) states that fish production is affected by three principal influences: the morphometric, edaphic, and climatic factors. When dealing with lakes in the same or similar climatic areas this third influence can be excluded, so from the first two factors the term morphoedaphic index (MEI) was brought into use. Simply stated, the MEI is total dissolved solids divided by mean depth. Ryder (1965) found that multiple regression of fish production on mean depth and total dissolved solids produced a highly significant relationship for the 23 lakes he studied. A complete historical review and evaluation of the MEI was conducted by Ryder et al. (1974).

Watsjold (1975) stated that cursory fish production data, as defined by gill net sampling, suggested the MEI may be a useful indicator of productivity in waters of the Matanuska-Susitna valleys.

The physical and climatological features of the Matanuska-Susitna valleys have been previously described in detail by Engel (1974).

Physical Characteristics of the Lakes:

Morphometric and other physical features of 31 lakes are presented in Table 1. The lakes range in surface area from 5 to 362 acres and from 17 to 177 feet in depth. Seven lakes, Lucille, Seymour, South Rolly, Lower Bonnie, Byers, Big No Luck, and Little No Luck, have permanent outlets; whereas the others are landlocked or have intermittent outlet discharge.

Table 1. Morphometric Data for Selected Lakes of the Matanuska-Susitna Valleys.

Lake	Surface (Acres)	Maximum Depth (Ft)	Mean* Depth (Ft)	Volume (Acre-Ft)	Shoreline Distant (Miles)	Shore** Development	Littoral*** Area (%)	Elevation (Ft)	Location
Kepler	45.0	74	29.7	1,338	1.705	1.82	27	90	T17N R1E Sec. 24
Echo	23.0	40	19.3	445	0.884	1.31	42	100	T17N R1E Sec. 24
Matanuska	61.5	83	34.4	2,117	1.619	1.55	23	100	T17N R1E Sec. 23
Canoe	21.0	28	15.3	322	1.060	1.68	50	95	T17N R1E Sec. 13
Harriet	5.1	31	12.4	63	0.365	1.15	61	75	T17N R1E Sec. 24
Long (A)	74.4	55	26.1	1,945	2.367	1.96	28	85	T17N R1E Sec. 13
Victor	13.5	55	24.4	330	0.567	1.14	38	100	T17N R1E Sec. 24
Irene	18.0	42	21.3	384	0.777	1.30	37	92	T17N R1E Sec. 13
Finger	362.0	44	15.5	5,622	7.765	2.91	54	347	T18N R1E Sec. 33
Knik	50.4	37	19.1	963	1.477	1.48	47	50	T16N R3W Sec. 24
Johnson	40.3	41	20.0	806	1.089	1.22	46	95	T16N R3W Sec. 14
Florence	54.6	41	17.6	962	1.553	1.50	53	190	T19N R5W Sec. 23
Lucille	362.0	20	5.7	2,051	4.210	1.58	99	321	T17N R1W Sec. 8
Meirs	16.8	73	36.1	606	0.658	1.12	26	50	T17N R2E Sec. 18
Seymour	229.0	19	7.0	1,605	3.144	1.48	88	300	T18N R2W Sec. 32
Reed	19.5	20	10.4	202	0.870	1.40	70	550	T18N R1E Sec. 8
Memory	83.0	21	7.3	607	2.386	1.87	88	450	T18N R1W Sec. 22
Christiansen	179.0	82	22.1	3,961	4.640	2.47	47	200	T26N R4W Sec. 29
Rocky	58.7	27	13.0	764	1.439	1.34	59	150	T17N R3W Sec. 21
South Rolly	107.7	63	26.8	2,883	2.288	1.57	35	190	T18N R5W Sec. 11
Loon	108.0	17	10.4	1,133	1.922	1.32	73	270	T18N R3W Sec. 36
Marion	113.0	42	20.6	2,324	2.652	1.78	33	150	T16N R4W Sec. 1
Long (B)	102.0	100						1,487	T20N R6E Sec. 20
Ravine	12.3	25	11.8	146	0.824	1.69	62	1,800	T20N R6E Sec. 24
Lower Bonnie	118.0	40	20.3	2,389	2.512	1.64	37	1,800	T20N R5E Sec. 23
Byers	325.0	177	66.6	21,635	4.009	1.58	15	816	T31N R5W Sec. 36
Junction	10.9	48	17.8	194	0.588	1.27	55	85	T17N R1E Sec. 15
Benka	123.0	70	31.6	3,894	3.667	2.35	25	500	T24N R4W Sec. 9
Big No Luck	67.9	40	15.0	1,021	1.995	1.73	53	245	T18N R5W Sec. 13
Little No Luck	34.1	37	13.8	470	1.115	1.36	59	234	T18N R5W Sec. 13
Prator	98.0	24	11.7	1,145	1.527	1.10	62	295	T18N R3W Sec. 25

* Mean depth is volume ÷ surface area.
** Shore development is the ratio of the length of shoreline to the circumference of a circle having the same area as the lake.
*** Littoral area is that portion of the lake less than 15 feet in depth.

Three lakes, Long (B), Lower Bonnie, and Ravine, are located in close proximity at elevations ranging from 1,487 to 1,800 feet, while Byers Lake is located at an elevation of 816 feet in the Denali State Park. The remaining waters are scattered throughout the valley floor below 600 feet elevation. Nine lakes are situated in a group referred to as the Kepler-Bradley Complex. The Complex, which is centered in the Matanuska Valley's rich farm land, includes Kepler, Echo, Matanuska, Canoe, Harriet, Long (A), Victor, Irene, and Johnson lakes.

Monitoring of monthly temperatures in 11 lakes began in 1973 and was continued on a lesser number throughout the 1974-1975 summers. Summer thermal patterns were almost identical for the past three years except for slight variations in surface water temperatures which fluctuate depending on daily air temperatures. Generally, lakes deeper than six or seven meters (20 to 23 feet) were thermally stratified for at least a portion of the summer. Those with maximum depths of 7 to 13 meters (23 to 43 feet) had hypolimnia that were generally above 40°F in summer, whereas the hypolimnia of deeper lakes remained near 40°F.

Although most deep lakes are dimictic, some do not mix completely during each circulation period. Incomplete vernal mixing occurs more often than incomplete fall mixing because breakup occurs shortly before the summer solstice when heat transfer to the water is rapid, causing stratification which limits circulation. During the fall mixing period heat loss from the water is gradual and extends over a relatively long period. The extent of fall circulation depends largely on the time of ice formation on the lake. If freeze-up is early, complete mixing may not occur in deeper lakes.

Lower elevation lakes in the Palmer area become ice-free during the first week in May. The three mountainous lakes (Lower Bonnie, Ravine, and Long (B)) do not become ice-free until the latter part of May. Vertical temperature series of low and high elevation lakes, with date of observation, are shown in Table 2. Comparisons of surface temperatures between high and low elevation lakes show that before August 15 surface temperatures of low elevation lakes were 3° to 7°F warmer than those of higher elevation lakes (Figure 1). After August 15 surface temperatures were nearly identical in both high and low elevation lakes.

Chemical Characteristics:

Detailed chemical characteristics of 41 Matanuska-Susitna valley lakes have been previously presented by Engel (1974) and Watsjold (1975). Waters in all but five lakes (Lower Bonnie, Ravine, Long (B), Prator, and Twelvemile) were characterized by a predominance of Ca^{++} among the cations and HCO_3^- among anions. Percentage of cations, as calculated from reactive weights, varied from 43.2 to 77.5% for Ca^{++}, 9.8 to 30.9% for Mg^+, 0.9 to 18.5% for K^+, and 4.7 to 29.2% for Na^+. Of the anions, HCO_3^- ranged from 63.0 to 94.2%, $SO_4^=$ from 1.3 to 19.7% and Cl^- from 2.6 to 22.4%. Carbonate was evident only in High Ridge Lake. Summer pH of surface waters ranged from 6.7 to 9.1.

Table 2. Vertical Distribution of Temperatures in Matanuska-Susitna Valley Lakes, 1975.

Depth (m)	Low Elevation Lakes* Matanuska 7/28	Johnson 7/28	Memory 7/28	High Elevation Lakes** Long 7/24	Ravine 7/24	Lower Bonnie 7/24
1	64	65	65	59	60	59
2	64	65	65	59	60	59
3	64	65	64	59	60	59
4	63	64	63	59	60	59
5	61	61	61	59	59	58
6	56	52	54	59	59	58
7	49	47		59		56
8	44	41		57		49
9	41	40		52		45
10	40	40		48		45
11	40	39		46		44
12	40	39		45		
13	39	39		44		
14	39			43		
15	39			43		
16	39			42		
17	39			42		
18	39			42		
19	39			42		
20	39			42		
21	39			42		
22	39			42		
23	39			42		
24	39			42		
25	39			41		

* Elevation less than 500 feet.

** Elevation over 1,000 feet.

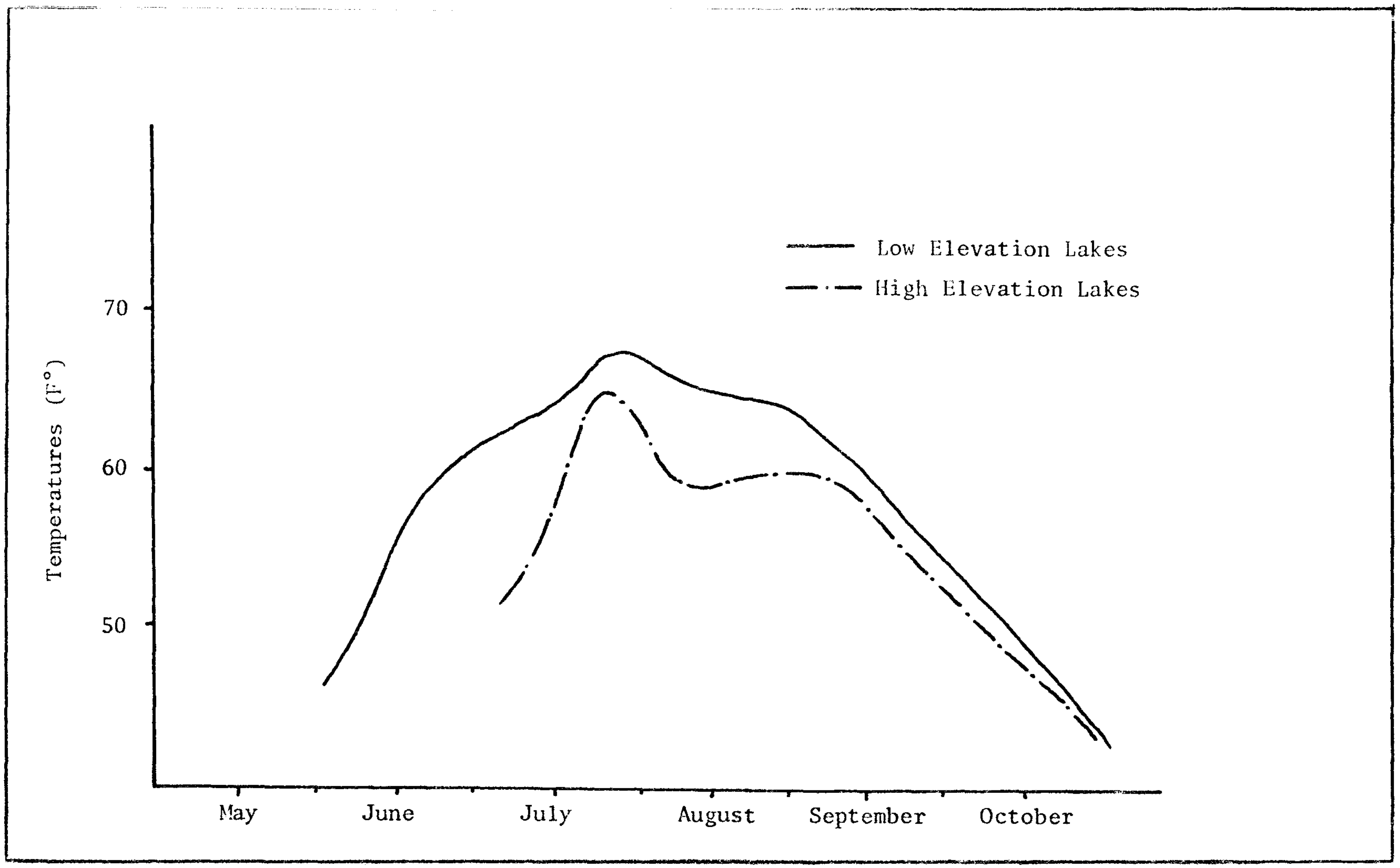

Figure 1. Surface Water Temperature of Six Matanuska-Susitna Valley Lakes, 1975.

The other five lakes had an abundance of sodium. Percentage of cations ranged from 26.1 to 41.3% for Ca^{++}, 11.8 to 22.3% for Mg^{+}, 0.5 to 7.9% for K^{+}, and 38.0 to 54.5% for Na^{+}. Bicarbonate varied from 67.3 to 89.3% of the reactive weight of anions.

The 41 lakes were ranked in a high-to-low order with respect to conductance, total hardness and total alkalinity (Table 3). The unusually high sodium levels in Long (B), Lower Bonnie, and Ravine lakes raised conductance values above the expected and they cannot be ranked or compared accordingly.

Dissolved oxygen determinations completed during past years have revealed considerable seasonal change. The extent of the change depends primarily on wind stress, thermal stratification, and biochemical oxygen demand. Typically, dissolved oxygen levels began to decline shortly after formation of winter ice cover, and continued to drop until late February through early March. Beginning in the latter half of March and continuing through April, O_2 concentrations of most surface waters begin to rise due to increased day length and higher solar angle which allows significant under-ice photosynthesis to occur. This change is probably more dramatic in those lakes where wind prevents heavy snow accumulation and in lakes which are relatively fertile. Also during this time, algal blooms have been observed which undoubtedly contribute to increased O_2 production during late winter.

The spring and fall mixing periods are extremely important in the replenishment of dissolved oxygen to all levels of a lake. Watsjold (1975) found that summer stratification occurred very rapidly in Matanuska Lake and that O_2 levels were not replenished below 12 m in the 25 m deep lake. An incomplete fall overturn left waters below 9 m completely devoid of O_2 when freeze-up occurred and subsequently general levels of O_2 declined even further during the winter months.

Since O_2 concentrations are at their lowest levels during late February and early March, this is the period when dissolved oxygen concentrations are measured in lakes where levels are normally low and in lakes having management potential. The 1974-1975 winter began with unusually heavy snowfall in November. On December 24, O_2 levels in Lucille Lake had declined to 0.3 ppm. It appeared that O_2 concentrations were going to be a critical factor in winter survival of salmonids in a few lakes, therefore a total of 27 lakes were tested for dissolved oxygen (Table 4). Eight lakes had surface O_2 levels ranging from 0.0 ppm to 2.5 ppm. Memory, Lucille, Seymour, Meirs, Canoe, and Matanuska lakes contained stocked fish. Through gill netting and observation of dead fish it appeared that complete winter-kill occurred in Meirs and Canoe lakes, while the other four lakes experienced partial winter-kill.

Indices of Productivity:

Watsjold (1975) stated that on the basis of conductance values alone that waters with values less than 100 micromhos/cm generally yield much poorer gill net catches than those having greater electrolytic concentrations. Although a simple ranking in high-to-low order with respect to conductance explains some differences in production between different bodies of water,

Table 3. Chemical Analysis of Selected Lakes of the Matanuska-Susitna Valleys, 1973-1974.*

Lake	Specific Conductance (micromhos/ cm at 25°C)	Total Hardness	Total Alkalinity
		---------mg/liter as $CaCO_3$---------	
Kepler	344	160	139
Echo	307	140	128
Matanuska	286	130	131
Canoe	277	130	112
Harriet	265	120	126
Long (A)	246	120	113
Falk	234	110	105
Junction	234	110	111
Victor	228	110	99
Irene	221	100	99
Klaire	219	110	108
Finger	206	98	107
High Ridge	193	85	85
Bairds	184	85	89
Knik	174	81	86
Johnson	148	64	71
Florence	137	69	69
Lucille	134	60	66
Meirs	122	41	50
Seymour	102	47	48
Seventeen Mile	65	23	29
Reed	54	22	25
Memory	41	18	21
Benka	41	16	18
Wishbone	41	15	20
Christiansen	40	19	20
Rocky	40	17	20
Byers	36	17	15
Tigger	34	12	16
South Rolly	31	13	19
Carpenter	29	11	12
Milo #1	19	5	7
Big No Luck	17	8	6
Chicken	14	4	6
Loon	13	5	5
Prator	11	3	4
Twelve Mile	10	2	3
Marion	9	3	4
Long (B)	434	110	189
Ravine	347	100	122
Lower Bonnie	205	66	97

* Analysis performed by U. S. Geological Survey.

Table 4. Lakes Tested for Dissolved Oxygen*, Matanuska-Susitna Valleys, 1975.

Depth (m)	Reed 3/13	Klaire 3/17	Forest 3/18	Memory 3/13	Loon 3/18	Visnaw 3/20	Morvro 3/20	Lucille 3/14	Lucille 4/7	Seymour 3/20	Seymour 4/22
1	11.0	0.0	4.1	2.2	12.7	9.5	12.8	0.0	0.0	1.8	2.5
3	1.8		1.0	0.7	8.0	3.3	6.2			1.4	0.6
6			0.2	0.1	5.0		1.2			0.6	
Ice (cm)	78.0	94.0	62.0	68.0	53.0	60.0	58.0	86.0	76.0	63.0	54.0
Snow (cm)**	4.0	T	11.0	4.0	15.0	10.0	12.0	10.0	5.0	10.0	3.0

Depth (m)	Echo 3/13	Victor 3/17	Tigger 3/27	Trouble 3/27	Irene 3/14	Bradley 3/19	Canoe 3/14	Harriet 3/17	Turning Point 3/20
1	6.8	6.1	8.5	7.0	9.0	5.2	0.5	3.8	9.2
3	5.8	5.0	4.6	0.8	8.3	3.2	0.2	3.4	8.0
6	3.4	0.4	3.9		4.7	2.9	0.3	1.8	6.2
9	2.5	0.0	3.2		2.0	1.0	0.0	1.2	
Ice (cm)	79.0	82.0	59.0	56.0	73.0	86.0	88.0	86.0	63.0
Snow (cm)**	T	T	31.0	30.0	T	T	T	T	34.0

Depth (m)	Long 3/17	Meirs 3/13	Kepler 3/19	Marion 3/18	Johnson 3/18	Junction 3/13	Matanuska 3/14	Big Benka 4/4	Christiansen 3/27
1	5.4	0.5	6.1	12.7	1.6	3.5	1.6	9.5	10.1
3	4.3	0.4	6.0	11.6	0.8	2.6	1.4	9.0	9.7
6	3.6	0.3	5.3	9.4	0.7	0.4	1.2	8.3	8.9
9	3.2	0.2	4.5	5.7	0.4	0.2	0.4	8.0	8.4
12	3.0	0.3	0.9	1.0	0.2	0.0	0.3	7.1	5.6
15	1.0	0.3	0.0				0.2		3.2
Ice (cm)	74.0	69.0	86.0	63.0	70.0	76.0	78.0	76.0	57.0
Snow (cm)**	0.0	T	T	15.0	T	0.0	0.0	30.0	27.0

* All measurements are in ppm.

** T (trace).

there are some lakes lower in the ranking that produce higher yields of fish than their ranked position would suggest. Therefore, some factors other than ionic concentrations are influencing the productivity in these lakes.

One factor that has substantial influence on a lake's productivity is its' mean depth. Most of the biological activity in a lake occurs in the littoral area; therefore, lakes with large littoral zones generally have a high level of productivity if accompanied by desirable inorganic chemical concentrations. It appears that lakes with conductance values less than 100 micromhos/cm have low levels of productivity regardless of the extent of the littoral area.

The morphoedaphic index takes into account the mean depth and chemical concentrations of a lake. It was stated that the MEI value is simply total dissolved solids divided by mean depth. Specific conductance values were used to determine the MEI of Matanuska-Susitna valley lakes since these values are readily obtainable and are correlates of total dissolved solids. It is important, when using specific conductance values, that they be collected during a short time span at the same time of year. Conductance values fluctuate considerably depending on the time of year and this fluctuation would have a significant influence on the MEI.

Specific conductance values used to compute the MEI values listed in Table 5 were collected during the spring overturn period and were analyzed by the U. S. Geologic Survey. Lucille Lake, having the highest MEI, is the most productive lake listed while Marion Lake, with the lowest MEI, is the least productive lake of those listed in Table 5.

Table 5. Morphoedaphic Index Values for Selected Lakes in the Matanuska-Susitna Valleys.

Lake	MEI	Lake	MEI
Lucille	23.5	Memory	5.3
Harriet	21.3	Reed	4.9
Canoe	18.1	Meirs	3.4
Falk	16.7	Rocky	3.1
Echo	15.9	Christiansen	1.8
Seymour	14.6	Benka	1.3
Finger	13.3	Loon	1.3
Junction	13.2	South Rolly	1.2
Kepler	11.6	Big No Luck	1.1
Irene	10.4	Twelve Mile	1.0
Long	9.4	Prator	0.9
Victor	9.3	Milo #1	0.7
Knik	9.1	Chicken	0.5
Matanuska	8.2	Byers	0.5
Florence	7.6	Marion	0.4
Johnson	7.4		

Kalb (1975) established a plankton index (PI) on 10 stocked lakes. He arranged the 10 lakes according to their PI which established a ranking of relative productivity for the lakes. MEI values assigned to each lake appeared to correspond to associated PI values. Kalb ran a regression analysis of 1974 PI on MEI and found a highly significant (99%) correlation of 0.88 between the two.

Another indicator of productivity is the degree of dissolved oxygen fluctuation during a specific time period. Biochemical oxygen demand during periods of restricted circulation is related to the productivity of a lake. During the winter of 1973-1974 dissolved oxygen concentrations were monitored in 11 lakes. The percentage of oxygen reduction during the winter months was determined for each of the lakes. A regression analysis between the percentage of O_2 reduction and the MEI of each lake revealed a strong linear relationship. Significant correlations existed between the two values (r=0.96) for the 11 lakes. Again it was Lucille Lake with the highest MEI which had the greatest reduction in O_2 while Marion Lake with the lowest MEI had the lowest reduction in O_2.

A combination of plankton indices, mean depth, water chemistry and O_2 deficiency were compared to the MEI on nine lakes where comparable data were available. Each lake was assigned a numerical number under each category. The number a lake received depended on how it ranked with the other lakes. The highest number (9) was given to the lake with the highest PI and water chemistry values, lowest mean depth value, and highest percentage of O_2 reduction. Lesser values were given to lakes according to their ranking among the nine lakes (Table 6). A regression analysis between the point totals and MEI of each lake revealed a strong linear relationship. Significant correlations existed between the two values (r=0.92) for the nine lakes.

Table 6. A Numerical Comparison of Biological, Chemical and Physical Properties with the Morphoedaphic Indices of Nine Matanuska-Susitna Valley Lakes.

Lake	PI	Mean Depth	Water Chemistry*	Oxygen Deficiency	Point Total	MEI
Lucille	8	9	6	9	32	23.5
Seymour	9	8	5	8	30	14.6
Long (A)	6	2	8	7	23	9.4
Matanuska	7	1	9	6	23	8.3
Johnson	5	5	7	4	21	7.4
Memory	3	7	4	5	19	5.3
Christiansen	1	3	3	2	9	1.8
Loon	4	6	2	3	15	1.3
Marion	2	4	1	1	8	0.4

* Based on specific conductance, total alkalinity, and hardness values.

An examination of growth rates of stocked game fish in lakes of varying productivity is a direct method of evaluating the MEI. Since a number of factors have substantial influence on growth rates, it is important that only comparative data be used in this type of evaluation. Time of stocking, stocking density, survival and size of stocked fish, are those factors that must be considered when comparing growth rates in different lakes.

Although a large amount of growth data are available for rainbow trout, Salmo gairdneri (Richardson) these data indicate correlations do not exist between rainbow trout growth curves and MEI. Condition factors of rainbow trout in lakes with low MEI values are equal to or exceed those found in lakes with high MEI values (Chlupach, 1976, in press). This discrepancy appears to be caused by extremely low survival rates of rainbow trout in rehabilitated lakes with a low MEI value. Low survival of stocked game fish reduces competition between those remaining trout, resulting in increased growth rates. Chlupach (1976, in press) determined that survival rates of stocked rainbow trout after one year of lake residency were only 9% in Marion Lake (MEI 0.4) and 3% in Christiansen Lake (MEI 1.8).

There are some coho salmon, Oncorhynchus kisutch, (Walbaum) growth data from stocked lakes that are comparable and these data are presented in Figure 2. Coho growth curves, as presented, show a direct correlation to the MEI of each of the five lakes. Lucille Lake which has the highest MEI also has the fastest growing coho while coho in Loon Lake, with the lowest MEI, grew at a much slower rate. The reasons cited for the discrepancy between the relationship of rainbow trout growth curves and MEI values are not valid for coho since coho do not exhibit poor survival in low productivity waters.

Lake Stocking Evaluations:

Sampling of stocked lakes is conducted to evaluate and develop stocking practices aimed at enhancing resident fish stocks.

In 1975, 20 stocked lakes were sampled under ice with variable mesh gill nets. As in the past, netting was directed toward determining growth of fish stocked the same year (age 0+) and the previous year (age 1+). Catches of older age groups are usually too small to allow comparative analysis. The netting also permits a gross evaluation of relative fish abundance.

Rainbow trout from Winthrop, Washington were stocked in the majority of managed lakes in 1974. Ennis trout were also stocked in 1974 but will not be evaluated in this report since they were included in the G-III-D report as part of an experimental program. Winthrop fish were planted in late June, 1974 as fingerling, weighing from 848 to 975/lb.

Gill net catch data and stocking histories are presented in Table 7. Samples taken 17 months after introduction indicate that 1974 Winthrop plants obtained mean lengths ranging from 209 mm in Wishbone Lake to 356 mm in Knik Lake.

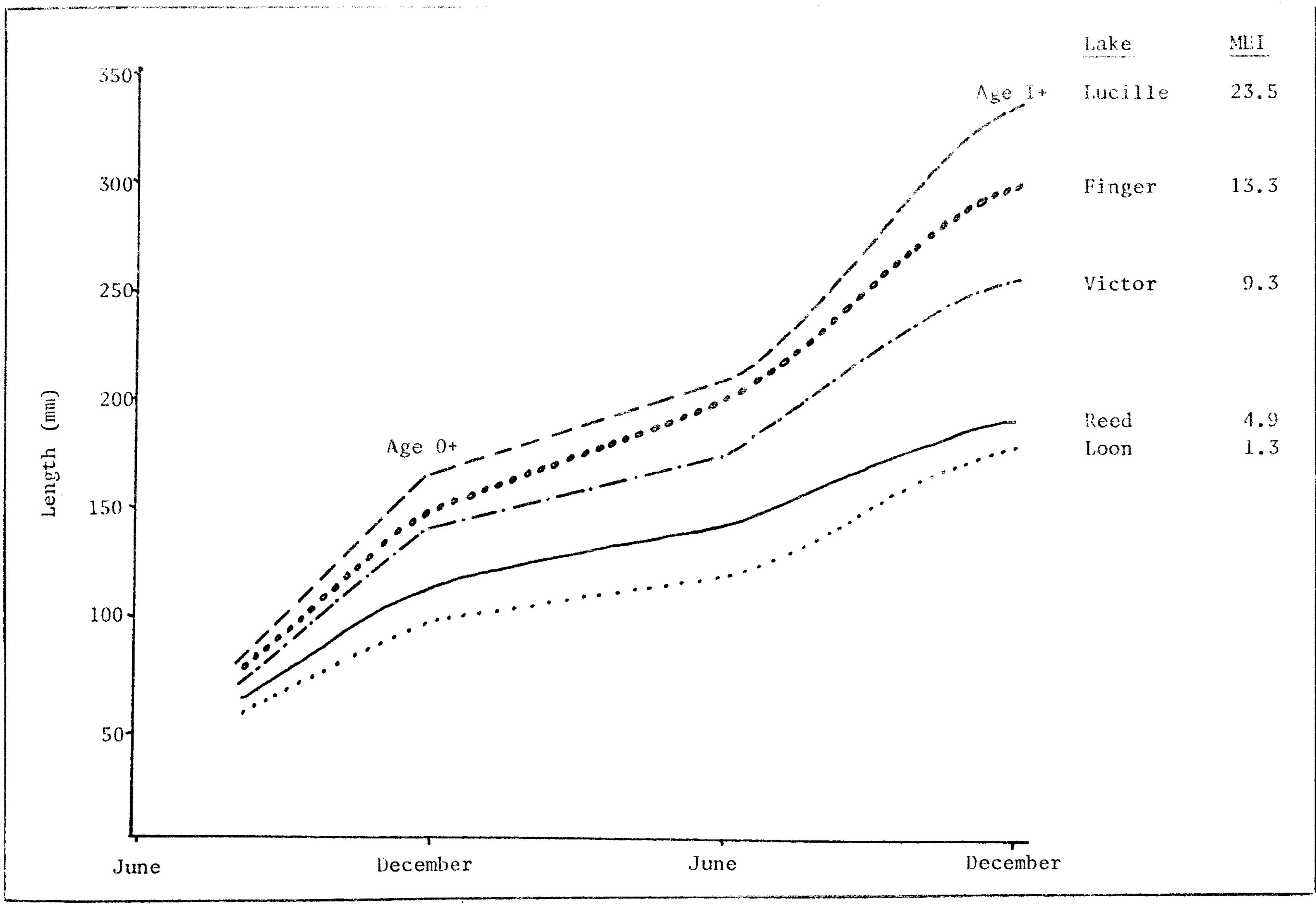

Figure 2. A Comparison of Coho Salmon Growth Rates with the Morphoedaphic Index in Five Matanuska-Susitna Valley Lakes.

Table 7. Gill Net Results and Stocking Histories of Managed Lakes, Matanuska-Susitna Valleys, 1975.

Lake	Date Sampled	Species*	Number	Age Class	Length (mm) Range	Mean	Catch/ Net Hr.	Date Stocked	Total Number**	Per Lb.	Per Acre
Kepler	11/12/75	RT	4	0+	148-175	162	0.08	7/21/75	8,700 EM***	138	150****
		RT	14	1+	212-267	246	0.30	6/24/74	102,500 W ***	975	1,770****
Bradley	11/12/75	RT	5	0+	158-200	175	0.22	7/21/75	8,700 EM***	138	150****
		RT	2	1+	250-317	283	0.08	6/24/74	102,500 W ***	975	1,770****
Irene	11/12/75	RT	6	0+	100-171	155	0.14	7/30/75	11,700 W	1,000	650
		RT	11	0+	185-205	193	0.26	7/30/75	3,200 EM	116	175
Matanuska	11/14/75	RT	48	0+	142-228	187	1.04	7/22/75	9,300 EM	138	150
Ravine	11/25/75	RT	73	0+	140-224	192	1.62	7/ 8/75	2,400 EM	207	200
		RT	1	III+	420	420	0.02	9/ 8/72	3,800 W	172	300
		RT	4	IV+	472-511	501	0.11	6/10/71	3,700 EM	162	300
Lower Bonnie	11/25/75	RT	5	II+	156-178	162	0.10	7/25/73	10,000 W	121	100
		RT	5	III+	214-226	221	0.10	Wild			
		RT	3	V+	319-326	323	0.06	9/14/70	12,200 W	74	125
		GR	17	I+	162-215	198	0.36	Wild			
		GR	2	II+	251-262	257	0.04	Wild			
Wishbone	12/ 2/75	RT	17	I+	155-235	209	0.38	6/28/74	33,500 W	848	560
Memory	11/18/75	RT	1	I+	400		0.02	6/24/74	46,500 W	975	560
Rocky	12/ 4/75	RT	7	0+	150-214	181	0.15	7/ 6/75	5,900 EM	207	100
		RT	4	I+	270-340	308	0.08	6/24/74	33,000 W	975	560
Seymour	12/12/75	RT	118	0+	137-240	201	2.62	7/ 2/75	69,000 EM	352	300
		RT	16	II+	410-500	437	0.35	7/ 6/73	257,600 W	1,178	1,125

Table [illegible] (Cont'd.) Gill Net Results and Stocking Histories of Managed Lakes, Matanuska-Susitna Valleys, 1975.

Lake	Date Sampled	Species*	Number	Age Class	Length (mm) Range	Length (mm) Mean	Catch/ Net Hr.	Date Stocked	Total Number**	Per Lb.	Per Acre
Knik	12/12/75	RT	48	0+	150-250	197	1.04	7/ 2/75	20,200 EM	196	400
		RT	7	I+	305-378	356	0.15	6/24/74	37,500 W	975	750
		RT	5	II+	422-510	469	0.10	6/30/73	20,000 EM	108	400
Echo	11/ 7/75	SS	15	0+	95-108	103	0.31	7/22/75	4,600 B	293	200
		SS	44	I+	165-235	195	0.91	7/ 9/74	6,900 S	227	300
Lucille	11/14/75	SS	84	0+	135-189	151	4.25	6/18/75	72,500 G	489	200
		SS	4	II+	329-500	419	0.20	7/ 2/73	55,500 S	525	150
Victor	11/19/75	SS	13	0+	138-160	147	0.33	6/18/75	2,700 B	489	200
		SS	24	I+	203-263	243	0.61	7/ 9/74	2,700 S	227	200
Finger	11/18/75	SS	11	0+	146-169	152	0.25	6/18/75	72,500 B	489	200
		SS	57	I+	211-345	296	1.29	7/ 9/74	108,600 K	924	300
Loon	12/ 4/75	SS	20	0+	98-116	105	0.47	7/22/75	10,800 B	293	100
		SS	38	II+	192-284	240	0.90	8/ 8/73	32,405 K-G	140	300
Prator	12/ 4/75	SS	61	II+	193-264	219	1.38	8/10/73	15,000 K	163	150
Meirs	11/20/75	GR	55	0+	153-179	167	1.25	6/25/75	10,000 T	Fry	625
Harriet	11/19/75	GR	2	0+	129-140	135	0.04	6/25/75	8,500 T	Fry	850
		GR	19	I+	193-233	223	0.44	6/11/74	16,400 T	Fry	1,640
Long	11/25/75	GR	7	I-V	263-444	351	0.14	Wild			

* Key: RT = rainbow trout; SS = coho salmon; GR = Arctic grayling.

** Key: W-Winthrop strain; EM-Ennis Montana strain; B-Bear Lake strain; K-Kodiak strain; S-Ship Creek strain; G-Green River strain; T-Tolsona strain.

*** Key: Represents total plant stocked into both Kepler and Bradley lakes.

**** Key: Density computed on total acreage of Kepler and Bradley lakes.

The majority of stocked lakes received plantings of Ennis, Montana rainbow trout in 1975. Ennis trout were planted from July 2-July 30 as fingerling, weighing from 116 to 352/lb. Average lengths of 1975 Ennis plants after 4.5 months of lake residency (0+ age class) ranged from 162 mm in Kepler Lake to 201 mm in Seymour Lake.

Coho salmon growth and survival rates were evaluated in Echo, Lucille, Victor, Finger, Loon, and Prator lakes. Mean lengths of age 0+ coho stocked in Lucille, Victor, and Finger lakes on June 18 ranged from 147 to 152 mm, while those age 0+ coho stocked in Echo and Loon lakes on July 22 averaged only 103 and 105 mm, respectively. Those coho stocked in June at 489/lb. were almost 50 mm longer than those stocked one month later at 293/lb. This is one example which illustrates the desirability of stocking fish early in the growing season, even though their size may be much smaller.

Growth curves were developed for coho salmon and rainbow trout in managed lakes (Figure 3). Only those fish stocked in late June and in July in lower elevation lakes were used to develop these growth curves.

For coho salmon the expected length of age 0+ fish ranges from 100 to 165 mm, with an average of 140 mm. When coho reach age 1+ they range from 185 to 335 mm and average about 240 mm in length. Age 0+ rainbow trout can be expected to be from 160 to 220 mm in length, with an average of 180 mm, while age 1+ rainbow trout will attain a size ranging from 250 to 355 mm and average 300 mm.

Chinook Studies:

Escapement surveys were conducted from July 28-August 5 in the Matanuska-Susitna valleys. Stream flows were slightly higher than normal but visibility was excellent in most streams. A total of 1,250 chinook salmon, *O. tshawytscha* (Walbaum) were actually observed during escapement surveys. Watsjold (1974) found that during aerial surveys approximately 70% of the chinook in alpine streams were observed and 55% of the chinook in streams flowing through heavily forested areas were observed. Based on these findings it was estimated that the 1975 chinook salmon escapement was 1,500, which is considerably lower than the 1973 and 1974 estimates of 8,900 and 4,100, respectively.

With the exception of Moose Creek, all surveyed streams revealed 1975 chinook escapements to be lower than in the two previous years (Table 8). Comparable fixed wing aerial surveys were conducted on eight streams in 1973, 1974, and 1975 which resulted in actual observation of 1,577, 1,212, and 404 chinook, respectively. Ground surveys on Willow Creek revealed only 177 chinook which is substantially below the 1969-1974 average of 490 chinook.

On May 26 and 27, 1971 a total of 32,000 adipose clipped chinook smolts originating from Ship Creek were planted in Willow Creek. In 1974 a total of 139 chinook carcasses (age 1.3) were checked for fin clips which represented 35% of the observed escapement into this system. Only two (1.4%) adipose clipped fish were observed. The remaining adipose clipped fish

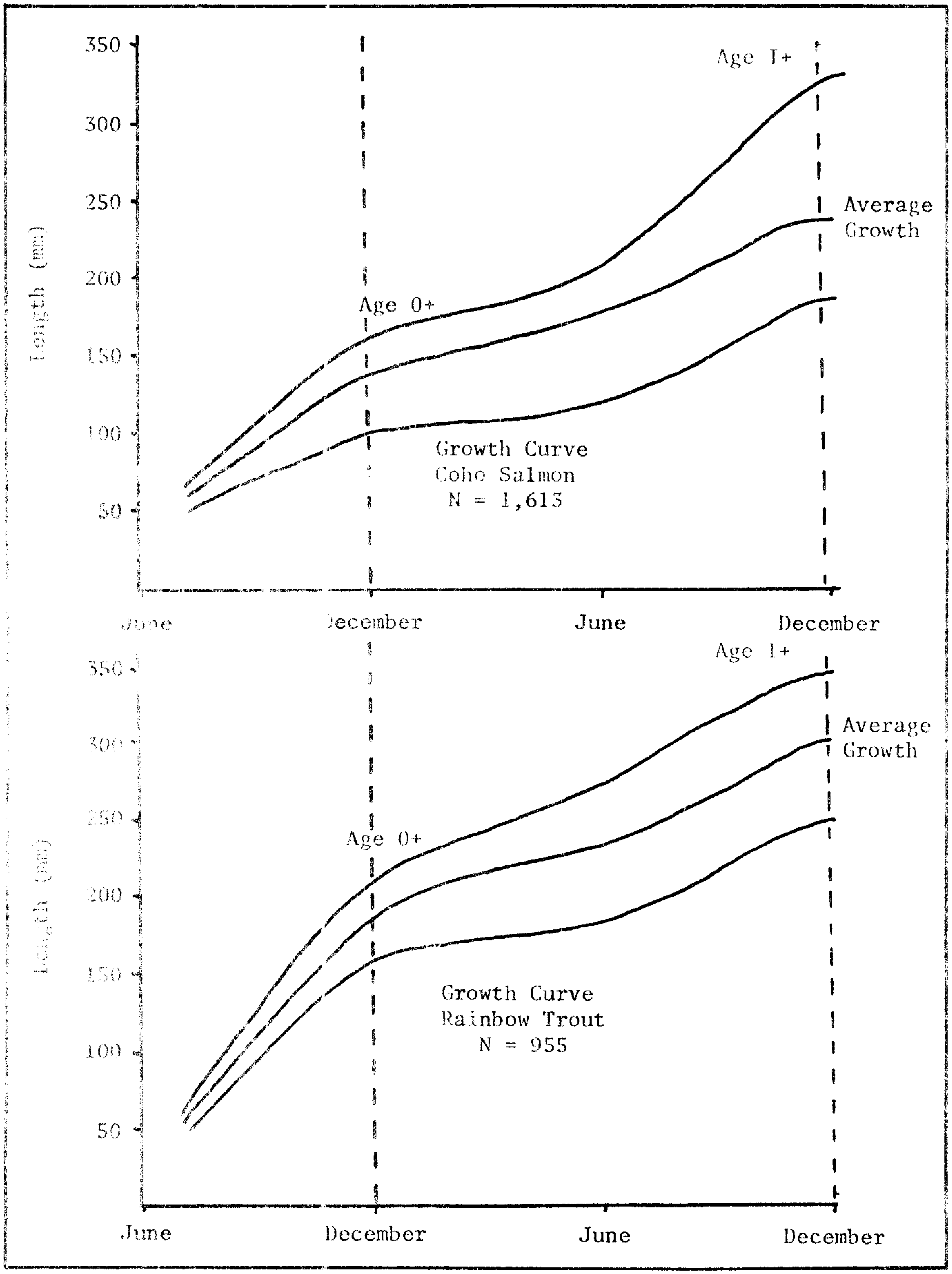

Figure 5. Growth Curves of Coho Salmon and Rainbow Trout Showing High, Low and Average Growth Expected in Stocked Matanuska-Susitna Valley Lakes Below 500 Feet Elevation.

Table 8. Observed Chinook Escapement Counts, Susitna and Matanuska River Tributaries, 1969-1975.

	Fixed Wing Aerial Surveys							Helicopter Surveys		
	1969	1970	1971	1972	1973	1974	1975	1973	1974	1975
Chunilna Creek	375	58*	5*	91	245	236		292	283	101
Kashwitna River (North Fork)	0		1	31	145	103		183	85*	33
Little Willow Creek		45*		99	233	109		371	139*	103
Sheep Creek				101	444	202	42	482		
Indian River				35	110	102	31	122		
Portage Creek				68	153	260	32	174		
Chulitna River (East Fork)					41	41	7	42		
Chulitna River (Middle Fork)					206	159	55	219		
Prairie Creek		820		630				3,286		
Goose Creek						41	13			
Little Susitna River								374		

Ground Surveys

	1969	1970	1971	1972	1973	1974	1975
Willow Creek	290	640	165	370	1,074	402	177
Montana Creek	150	161	44	317	527	280	229
Moose Creek		126	40	21	36	32	55
Prairie Creek					4,190	1,498	369

* Poor Conditions.

should have returned as age 1.4 in 1975. Unfortunately, the 1975 chinook escapement was one of the lowest on record. The low escapement, coupled with extremely high water levels immediately after the peak spawning period, precluded the effective recovery of carcasses.

Coho Studies:

Foot surveys were conducted in escapement index areas on seven streams to estimate spawning coho salmon populations.

A summary of coho escapement counts in index areas is presented in Table 9. The 1975 escapement counts on several streams were higher than previous years' averages. An additional index area was established on Rabideau Creek, a tributary of the Susitna River.

Table 9. Numbers of Coho in Escapement Index Areas (Foot Counts), Upper Cook Inlet, 1968-1975.

Stream	1968	1969	1970	1971	1972	1973	1974	1975	Average 1968-74
Wasilla			101	104	19	28	30	49	56
Cottonwood	22	9	5	29	21	10	2	73	14
Birch	125	142	206	138	69	106	49	92	119
Fish		552	176	141*	118	75	256	455*	270
Meadow	54	109	49	9	27	14	22	7	41
Question						59	3	111	31
Rabideux								67	
Total	201	1,112	537	421	254	292	362	854	

* Due to high water a boat count was necessary.

A total of 73 coho were enumerated in the Cottonwood Creek index area. This is the highest escapement in this area since the counts began in 1968. Several other spawning areas on Cottonwood Creek were walked, and an additional 160 coho observed.

Although 49 coho were observed in the Wasilla Creek index area, an additional 158 coho were observed in a two-mile stretch immediately upstream from the index area. Water fluctuations in Wasilla Creek appear to have an important influence on spawning distribution; when water levels are high, coho move farther upstream to spawn, as occurred in 1975. The index area will be extended to include the two-mile stretch that was counted in 1975. Fishing success in the lower portion of Wasilla Creek was very high during the weekends when a portion of the stream was open to salmon fishing. Although no formal creel census was conducted it was estimated from spot angler checks that the coho catch exceeded 1,500 during the three weekends when fishermen were checked. The better than average coho run into Wasilla Creek were offspring from the parent year escapement of 1971. If index counts are a reliable indicator of run strength, the 1976 escapement into Wasilla Creek will be extremely poor because the parent year escapement in 1972 was the lowest on record in the index area.

Although coho escapements in 1975 were better than in the past four years in Wasilla and Cottonwood creeks, the escapements on Birch and Meadow creeks were below average.

The weir on Fish Creek has allowed index area escapement counts of Fish and Meadow creeks to be evaluated against a known escapement. Table 10 shows the percent of the total weir count of coho that were counted in the two index areas. During the five years when evaluation was possible, the Fish Creek index area counts have varied from 16.5% to 37.7% (average 24.6%) of the run entering the Big Lake system, and the Meadow Creek index area counts have varied from 0.4% to 6.7% (average 3.1%).

Table 10. Evaluation of Fish and Meadow Creeks Coho Index Area, 1969-1975.

Year	Dates of Operation	Weir Counts	Fish Creek Index Area	% of Weir Count	Meadow Creek Index Area	% of Weir Count
1969	7/14-9/ 2	4,253	852	20.0	109	2.6
1972	7/ 2-9/ 8	716	118	16.5	27	3.8
1973	7/ 1-9/ 6	210	75	35.7	14	6.7
1974	7/ 8-9/ 6	1,154	256	22.2	22	1.9
1975	7/ 3-9/11	1,601	455	28.4	7	0.4

Access Activities:

The conveyance of public lands to native corporations as a result of the Native Land Claims Act poses the most serious threat to the continued expansion of the area's sport fisheries. Many areas presently being utilized by fishermen may be inaccessible if easements are not obtained through lands being withdrawn from public ownership. There are presently inaccessible waterways with recreational potential within proposed withdrawals. If easements are not obtained to these waterways they may never be accessible to the public.

Recommendations for 13 public easements were submitted to the Habitat Section along with documentation of past, present, and future "use" of each easement requested.

Discussion

The highly significant relationships between the MEI and the various parameters discussed indicate that the MEI may be a representative indicator of biological productivity. It would not be practical to use some of the various parameters as indicators of productivity due to the time involved in collecting the data. The MEI is readily calculated and reflects major changes in the environment which suggests its promise as a ready index of biological productivity.

To determine the reliability of the MEI as the primary indicator of productivity in Matanuska-Susitna valley lakes will take several more years. Other biological and chemical factors which are indicators of productivity must be further studied and compared to the MEI of various waters. Fish production data will ultimately determine how useful the MEI will be in lakes of varying fertility.

To compare average growth rates of salmonids in managed lakes located in the Matanuska-Susitna valleys is difficult because of the variety of strains stocked in lakes with varying productivity. Growth curves can be established for coho salmon and rainbow trout that will reflect the expected growth for these two species during their first two growing seasons. To develop such a growth curve requires sufficient data that are comparable since there are a large number of variables that affect fish growth.

The lower growth rates are generally exhibited in salmonids stocked in lakes with low productivity while the highest growth rates for salmonids are found in those lakes which are highly productive.

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